727

Electronic Calibration Lab
7000 Franklin Blvd., Suite 1220
Sacramento, CA. 95823
(916) 392-5404

HICKOK

LEADER IN DEPENDABILITY SINCE 1910

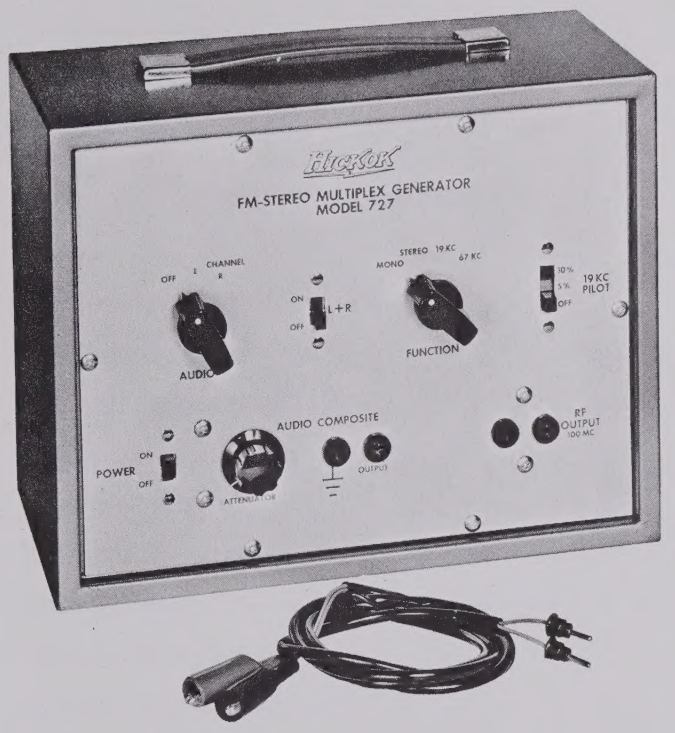
INSTRUCTION MANUAL

for

MODEL 727

FM-STEREO MULTIPLEX GENERATOR

THE HICKOK ELECTRICAL INSTRUMENT COMPANY • 10514 DUPONT AVENUE • CLEVELAND 8, OHIO



MODEL 727

FM-STEREO MULTIPLEX GENERATOR

© THE HICKOK ELECTRICAL INSTRUMENT CO. — 1964

10514 DUPONT AVENUE • CLEVELAND 8, OHIO

PHONE — 541-8060
TWX — CV 662

CABLE — HICKOK, CLEVELAND
WESTERN UNION — KJ

2490-491

TABLE OF CONTENTS

SECTION 1 - GENERAL INFORMATION

Paragraph		Page
1-1	This Manual	1-1
1-2	Historical Background	1-1
1-3	Description	1-1
1-4	Specifications	1-1

SECTION 2 - OPERATION

2-1	General	2-1
2-2	Explanation of Controls and Connectors	2-1
2-3	Test Procedures	2-2
2-4	Left and Right Channel Balance	2-4
2-5	Test and Alignment of Separation	2-4
2-6	Separation Ratio	2-5
2-7	Check and Alignment of 38KC Sub-Carrier	2-6
2-8	19KC and 38KC Filter and Oscillator Alignment	2-6
2-9	Check of Tuner Response	2-7
2-10	Matching of Tuner and Adapter	2-7

SECTION 3 - MAINTENANCE

3-1	General	3-1
3-2	Audio Composite Output Amplitude Check	3-1
3-3	Left Plus Right Vs. Left Minus Right Balance Check	3-2
3-4	19KC Pilot Phase and Amplitude Check	3-3
3-5	Audio Phase Check	3-3

SECTION 4 - CIRCUIT DESCRIPTION

4-1	General	4-1
4-2	1KC Audio Oscillator	4-1
4-3	Phase Inverter	4-1
4-4	19KC Oscillator	4-2
4-5	19KC : 38KC Doubler	4-2
4-6	AM Modulator	4-2
4-7	38KC Carrier Suppressor	4-2
4-8	Audio Composite Adder	4-2

TABLE OF CONTENTS (Cont)

SECTION 4 - CIRCUIT DESCRIPTION (Cont)

Paragraph		Page
4-9	Audio Phase Delay	4-2
4-10	67KC Oscillator	4-2
4-11	Amplifier and Emitter Follower	4-2
4-12	RF Oscillator and FM Modulator	4-2

SECTION 5 - PARTS LIST

5-1	Introduction	5-1

LIST OF ILLUSTRATIONS

SECTION 1 - GENERAL INFORMATION

Figure		Page
	FM-Stereo Multiplex Generator - Model 727	Title Page

SECTION 2 - OPERATION

2-1	Table Showing Function or Purpose of Front Panel Controls and Connectors	2-1
2-2	Test Setup Using One Oscilloscope or One Vacuum Tube Voltmeter	2-2
2-3	Test Setup Using Two Oscilloscopes or Two Vacuum Tube Voltmeters	2-2
2-4	Test Setup Using One Dual Channel Oscilloscope . .	2-2
2-5	Table Showing Outputs and Corresponding Control Settings	2-3
2-6	Typical 1000cps Sine Wave	2-5
2-7	Table Showing Relation Between Decibels and Voltage Ratios	2-5
2-8	Properly Balanced Right or Left Channel	2-7

SECTION 3 - MAINTENANCE

3-1	Bottom View of Chassis Showing Calibration Controls.	3-1
3-2	Properly Balanced Right or Left Channel Signal. . .	3-1
3-3	Improperly Balanced Right or Left Channel Signal . .	3-2
3-4	Top View of Chassis Showing Calibration Controls. .	3-2
3-5	Side Bands of Left or Right Channels Only	3-2
3-6	Incorrect 19KC Phase Adjustment	3-3
3-7	Correct 19KC Phase Adjustment.	3-3

SECTION 4 - CIRCUIT DESCRIPTION

4-1	Block Diagram, FM Stereo Multiplex Generator, Model 727	4-1
4-2	Schematic Wiring Diagram, Model 727.	Back of Manual

SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION

The Model 727 FM Stereo Multiplex Generator represents a major design breakthrough resulting for the first time, in a popularly-prices test instrument that meets the needs of in-home stereo FM service without the expense and complexity of a standard generator. Using a double side band suppressed carrier signal, the generator provides a correct signal for adjusting all types of FM stereo systems for maximum separation.

The public interest in stereo broadcasting and receiving is fast getting beyond the exclusive province of the "stereo buff". Standard FM broadcasting will no longer satisfy the millions of people who have been educated to really fine music and voice reproduction. However, the best of receivers and associated equipment can give but indifferent response if the components are not properly balanced and aligned. Hickok's history of always being the first to supply the serviceman with the finest of test equipment, that he may keep ahead of his competitors, is epitomized in this portable, self-contained test unit.

1-2. HISTORICAL BACKGROUND

FM stereophonic broadcasting became a reality June 1, following the Federal Communication Commission's announcement April 19, 1961, of the stereophonic standards established for the Broadcast Industry. In essence and overly simplified the standards were:

a). The approximately 17 million domestic receivers in use at that time must not be made obsolete. The new system of stereophonic broadcasting must be compatible with the existing domestic receivers and the left (L) and the right (R) channel information (music and voice) must blend in monaural receivers to form monophonic response equal to, or superior to, standard single channel FM broadcasting;

b). The new broadcast equipment must be truly stereophonic with a left and right channel separation of a minimum of 30 db over the entire audible frequency range;

c). Special provision was made for broadcasters who wanted to utilize 10% of their allocated frequency space to broadcast "piped" or "storecast" music simultaneously with their stereo FM programs. This was an economic advantage to many broadcasters as it provided an additional source of revenue. This 10% of their allocated space was called SCA (Subsidiary Communications Authorization). This SCA broadcast could be sold by the broadcasters to restaurants, taverns, factories, stores, etc., for a fee, to provide them with music without interruptions for announcements or station "breaks";

d). In the event that both stereo and SCA signals are transmitted, the station carrier must be frequency modulated by the stereo component to not more than 90% of peak deviation to allow the remaining 10% for SCA broadcasting.

1-3. DESCRIPTION

These rules and regulations as set out by the FCC require rather complex receiver circuitry which is difficult to service without special equipment. However, with the Hickok Model 727 FM-Stereo Multiplex Generator, servicing of domestic FM-stereo receivers and tuners is simple, fast, and accurate. The Model 727 generates a complete, composite FM multiplex signal in accordance with FCC specifications. Because it is self-contained and generates its own 1000 cps right (R) or left (L) channel test signal no outside signal source is required. When used with an oscilloscope or an AC VTVM (vacuum tube voltmeter) all signals can be shown which are essential and desirable to facilitate alignment, calibration, signal tracing, etc.

1-4. SPECIFICATIONS

Outputs

a). The AUDIO COMPOSITE OUTPUT consists of a left or right (L + R) 1000 cps (±10%) sine wave; sidebands of L or -R (L - R) with a 38KC (±4cps) suppressed sub-carrier; and a 19KC (±2cps) pilot frequency. This output is continuously variable from 0 to 4 volts, peak-to-peak, with the pilot frequency portion comprising 10 to 12% or 5 to 6% of the total composite output at any output level determined by the 19KC PILOT switch setting).

b). The MONO (monaural) signal output is a 1KC sine wave with a peak-to-peak amplitude of 1.8 volts (±10%).

c). The 19KC CW signal output is a sine wave of at least 0. 5 volt, peak-to-peak amplitude with a crystal controlled frequency accuracy of ±2cps.

This 19KC CW signal output is used to synchronize locked oscillators, for signal substitution, and signal tracing.

d). The 38KC CW signal output, derived from the 19 KC signal is a sine wave of at least 2 volts, peak-to-peak, but not more than 4 volts, peak-to-peak, with a frequency accuracy of ±4cps. It is used for signal injection with the purpose of alignment of stereo receivers or adapters.

e). The 67KC CW signal output is a sine wave of at least 2 volts, peak-to-peak amplitude for adjustment of the Subsidiary Communications Authorization (SCA) trap.

f). The 100MC RF OUTPUT (approx. 500 micro-volts) is frequency modulated with any of the above audio composite output signals for connection to the antenna terminals of the FM receiver or tuner.

Channel Separation

35 db or better

Correct for All Detection Systems

Because the Model 727 generates a standard

stereo signal it is fully compatible and correct for use with any detection system; beam switching, matrixing, or envelope detection.

Power Required

22.5 volt dry battery - Burgess No. 4156, Eveready No. 763, or equivalent. Battery is mounted inside case. An accessory plug-in, 110v. 60 cps, power supply is available for the Model 727, for continuous duty installations. It is interchangeable with the battery supply in a few moments.

Dimensions

11 inches wide, by 8-1/2 inches high, by 5 inches deep.

Finish

Baked "Woodsmoke" Grey Enamel.

Weight

6 pounds.

SECTION 2

OPERATION

2-1. GENERAL

The Model 727 is completely self-contained and is powered by a 22.5 volt dry battery. This battery is not supplied with the instrument. Either a Burgess No. 4156, an Eveready No. 763, or equivalent is recommended.

For battery installation, remove access cover plate located on the back of the generator. Hook-up and install the battery (red lead to positive side of the battery). Replace the cover plate. Battery life is estimated at 100 hours based on 4 hours of use daily. It is recommended that the generator be turned off when not in use to conserve battery life.

No adjustment of the generator is required as it has been fully factory adjusted, balanced, and inspected. Do not experiment with the screwdriver controls on the back, on the bottom, or on the side of the instrument as they have been properly adjusted at the factory.

2-2. EXPLANATION OF CONTROLS AND CONNECTORS

The Model 727 is an extremely versatile instrument specifically designed for efficient testing of FM stereo multiplex receivers and adapters. Its full utility can only be realized however, when the function and purpose of each of the front panel controls and connectors is understood. The function and purpose of each of these controls and connectors is explained in detail in Table 2-1.

CONTROL OR CONNECTOR	FUNCTION OR PURPOSE
AUDIO Selector	Three position selector switch: 1). OFF: L and R CHANNEL signals off. Also used in conjunction with FUNCTION selector for 38KC output. See Figure 2-5. 2). L: Left CHANNEL is on. 3). R: Right CHANNEL is on.
ON-OFF L + R	Two position slide switch: 1). ON: The L + R is applied to the composite adder. 2). OFF: With the 19KC PILOT switch in the 10% position, and the FUNCTION selector in the STEREO position, the AUDIO COMPOSITE signal consists of the subchannel information and the 19KC pilot frequency, only. This signal is needed for carrier phase adjustment.
FUNCTION Selector	Four position selector switch: 1). MONO: The output is a monaural signal. 2). STEREO: The output is a composite stereo signal. 3). 19KC: The output signal is a 19KC sinewave. 4). 67KC: The output signal is a 67KC sinewave.
19KC PILOT 10%, 5%, OFF	Three position slide switch: 1). 10%: The 19KC pilot signal is applied to the composite adder stage so that its amplitude is 10% of that of the total composite audio signal. 2). 5%: The 19KC pilot signal is reduced to half of its nominal amplitude. 3). OFF: The 19KC pilot signal is disconnected from the audio composite adder.
POWER ON - OFF	Used to turn the battery supply voltage "ON" or "OFF".
AUDIO COMPOSITE ATTENUATOR	Provides for zero to maximum attenuation of any signal obtained at the audio composite output.
AUDIO COMPOSITE OUTPUT	Output jacks supply MONO, STEREO, 19KC, 38KC, and 67KC signals.
RF OUTPUT 100MC	Output jacks supply 100MC RF (radio frequency) signal to antenna terminals of multiplex receiver or tuner.

Table 2-1. Function or Purpose of Front Panel Controls and Connectors

2-3. TEST PROCEDURES

Because of the many FM stereo adapters and FM stereo tuners on the market, the following instructions for testing and aligning stereo adapters and stereo tuners are not specific but general in their scope. For specific instructions for a particular adapter or tuner, refer to the manufacturer's service manual for that unit.

The following alignment instructions are for either an FM stereo tuner or stereo adapter. However, the following specific rule will apply.

a). When servicing a stereo adapter, obtain the output signals from the AUDIO COMPOSITE OUTPUT connector of the Model 727;

b). When servicing a stereo tuner, obtain the output signals from the RF OUTPUT - 100MC connector of the Model 727.

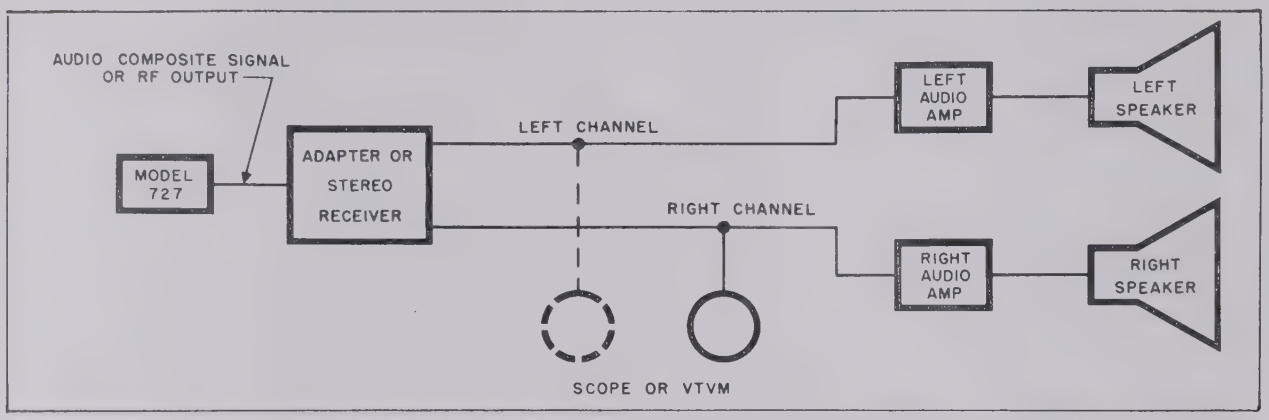


Figure 2-2. Test Set-Up Using One Oscilloscope OR One Vacuum Tube Voltmeter

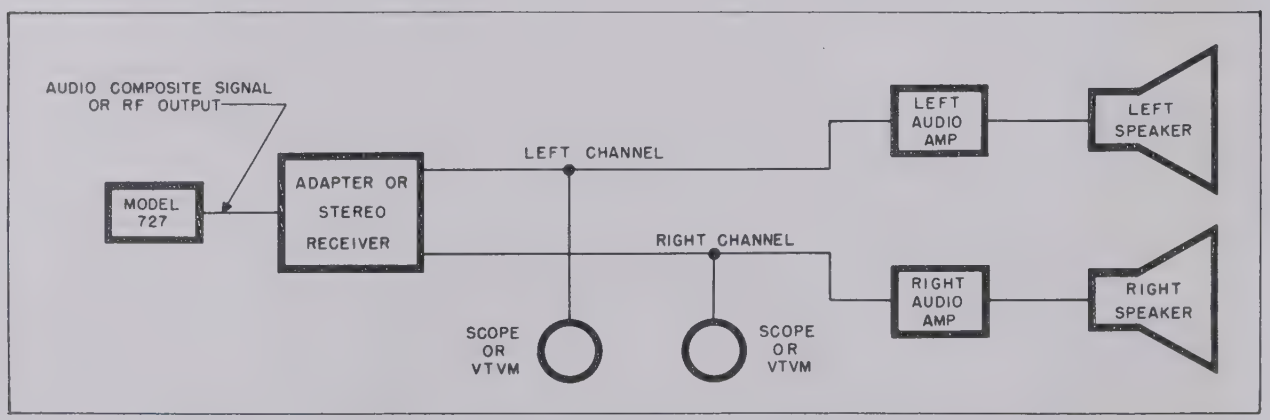


Figure 2-3. Test Set-Up Using Two Oscilloscopes OR Two Vacuum Tube Voltmeters

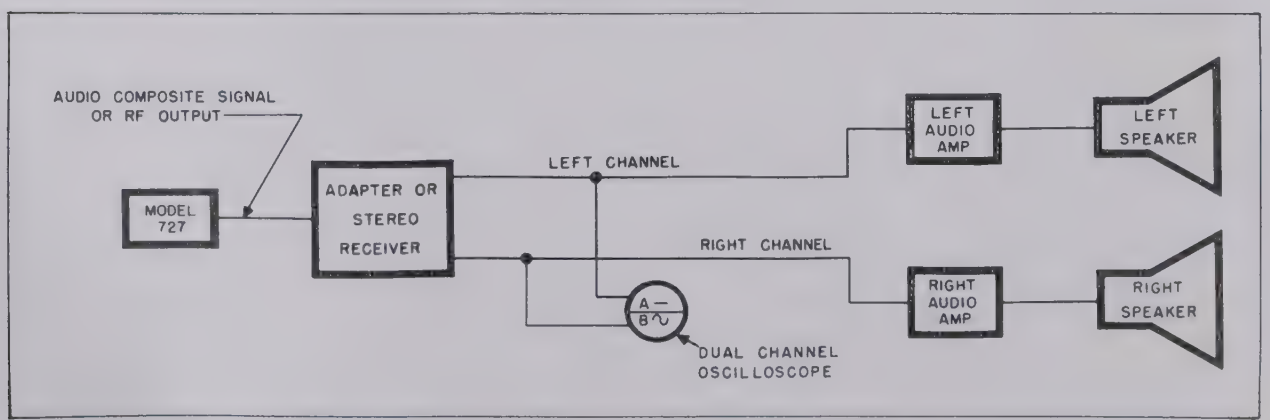


Figure 2-4. Test Set-Up Using One Dual Channel Oscilloscope

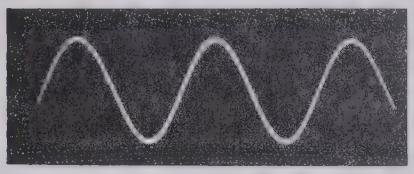
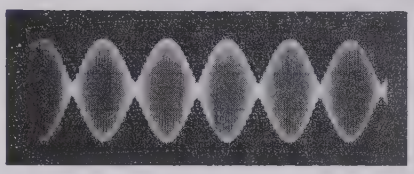
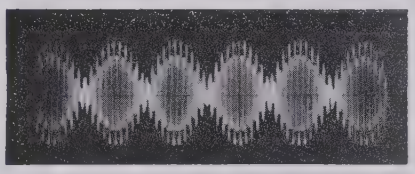
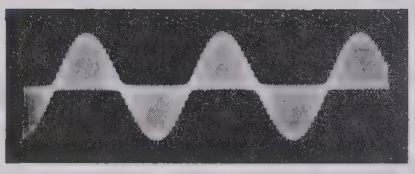
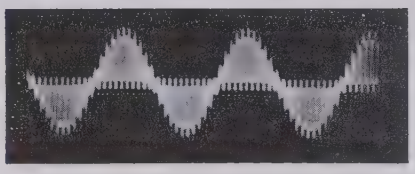
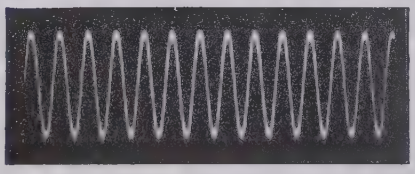
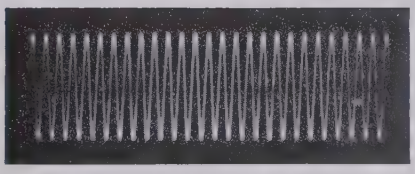
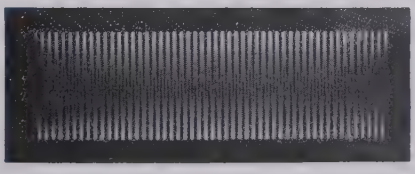
OSCILLOSCOPE DISPLAY	DESIRED OUTPUT	CONTROL SETTINGS			
		AUDIO SELECTOR	L+R	FUNCTION SELECTOR	19KC PILOT SELECTOR
	L Mono	L CHANNEL	ON	MONO	N/A
	R Mono	R CHANNEL	ON	MONO	N/A
	Sidebands of L without 19KC Pilot	L CHANNEL	OFF	STEREO	OFF
	Sidebands of -R without 19KC Pilot	R CHANNEL	OFF	STEREO	OFF
	Sidebands of L with 19KC Pilot	L CHANNEL	OFF	STEREO	5% or 10%
	Sidebands of -R with 19KC Pilot	R CHANNEL	OFF	STEREO	5% or 10%
	L Channel Composite Signal without 19KC Pilot	L CHANNEL	ON	STEREO	OFF
	R Channel Composite Signal without 19KC Pilot	R CHANNEL	ON	STEREO	OFF
	L Channel Complete Composite Signal	L CHANNEL	ON	STEREO	5% or 10%
	R Channel Complete Composite Signal	R CHANNEL	ON	STEREO	5% or 10%
	19KC Sine Wave	N/A	N/A	19KC	N/A
	38KC Sine Wave	OFF	N/A	STEREO	OFF
	67KC Sine Wave	N/A	N/A	67KC	N/A

Figure 2-5. Table Showing Outputs and Corresponding Control Settings

The availability of associated test equipment and operator convenience determines which of three possible test set-ups will be used in testing. Figures 2-2, 2-3, and 2-4 indicate various possibilities. Visual inspection of wave patterns offers advantages over voltage readings alone. Therefore, an oscilloscope or oscilloscopes are to be desired over one or two AC VTVM's when testing Likewise two indicating devices are to be preferred over one. But regardless of what indicators are used with the generator, equal results may definitely be expected. Electronically the hook-ups are identical, therefore in the interest of simplification these instructions will consider a single channel oscilloscope as an indicating instrument, except where the contrary is specifically noted.

> NOTE
>
> The input level to the unit under test is very important. Adapters may require various voltages from 0.2 volts to 2.0 volts RMS for normal operation. If the generator is not set to produce a sufficiently high level of input to the unit under test, "motorboating" or distortion will result. This could be caused by the 19KC pilot signal being too weak to synchronize the demodulator system. Whereas, too large an input signal may cause distortion and poor separation.

2-4. LEFT AND RIGHT CHANNEL BALANCE

Before testing or adjusting the left (L) or right (R) channel separation, it is desirable that the output of both channels be equal and in balance. Before testing for balance, it is necessary to determine the input sensitivity of the unit under test.[1] Refer to the manufacturer's service manual for this information. If this information is not readily available, refer to paragraph "b" of this section, and disregard paragraph "a" which immediately follows.

a). To check the balance where the input sensitivity is known, connect the proper output of the Model 727 to the indicating instrument.

1). Turn the indicating instrument to "ON" and allow at least 30 minutes warm-up time for it to become stabilized.

2). Set the controls of the Model 727 as indicated for L Channel Complete Composite Signal in chart, Figure 2-5, and turn the POWER switch to "ON".

3). Connect the indicating instrument to the AUDIO COMPOSITE OUTPUT connector and adjust the voltage or amplitude, by means of the AUDIO COMPOSITE ATTENUATOR, to the input sensitivity level specified by the manufacturer's service manual.

4). Without changing the position of the AUDIO COMPOSITE ATTENUATOR, disconnect the indicating instrument.

5). Connect the proper output of the Model 727; the adapter or tuner to be tested; and the indicating instrument as shown in Figure 2-2.

6). Without changing the position of the AUDIO COMPOSITE ATTENUATOR, set the remainder of the controls of the Model 727 as indicated for L Mono output in chart, Figure 2-5.

7). Adjust the balance control on the unit under test for equal output of both channels. For this test one indicating instrument is to be preferred as one indicating instrument avoids the possibility of a slight difference in instrument accuracy. During the test, alternately connect the left and the right channel outputs to the indicating instrument to confirm that the above condition (equal output) has been met.

b). To check the balance when the input sensitivity is not known and a manufacturer's service manual is not available, a close approximation of the proper operating level may be determined as follows:

Connect the output (second detector) of the stereo tuner to an oscilloscope (a VTVM is not adequate) and observe the output signal while the receiver is tuned to a station broadcasting a stereo signal. The maximum signal amplitude as observed on the oscilloscope can then be used as a reference for the input level of the unit under test. This reference level is equivalent to the total composite signal.

With the input sensitivity approximated by the above method and using this as a reference amplitude, refer to paragraph "a" of this section and proceed to steps 4 through 7 as outlined. Some experimentation with the AUDIO COMPOSITE ATTENUATOR on the Model 727 may be necessary to slightly vary the input level as approximated.

c). The procedure as outlined in paragraph "b" is based on the assumption that the tuner and adapter are matched units, i. e., made by the same manufacturer as companion units. If such is not the case, it will be necessary to experiment with various output levels of the Model 727 to obtain the best results possible with the particular adapter and tuner under test.

2-5. TEST AND ALIGNMENT OF SEPARATION

As a prerequisite to testing and aligning the separation of the left (L) and right (R) channels, it is desirable that the output of both channels be equal and in balance. If this has not been done, perform Left and Right Channel Balance as outlined in section 2-4.

To test and align the separation of a stereo adapter or tuner proceed as follows:

1). Connect the proper output of the 727 (see Section 2-3a and 2-3b for correct output) to the adapter or tuner to be tested.

2). Connect the indicating instrument to the R channel output of the adapter or tuner.

1/ Disregard this step if RF OUTPUT is used.

3). Turn the power switch of all equipment involved to the "ON" position. All units employing vacuum tube circuitry should be given at least 30 minutes warm-up time to become stabilized.

4). Set the controls of the Model 727 as indicated, for L Channel Complete Composite Signal in chart, Figure 2-5.

5). Observing the indicating instrument, adjust the separation control of the unit under test for minimum left channel information at the right channel output. Ideally, at this point no signal will be displayed, indicating perfect separation. In the event of insufficient separation, some left channel information (1000 cps audio signal) will be present in the right channel output.

NOTE

Most stereo tuners and stereo adapters have one separation control. In adjusting units that have two such controls (one for the left and one for the right channel) care must be exercised in selecting the proper one to adjust in each instance.

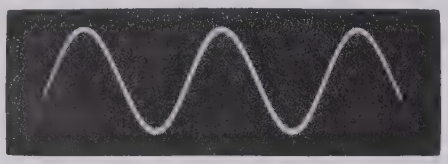


Figure 2-6. Typical 1000 cps Sine Wave

6). Change the test lead from the R channel output of the unit under test to the L channel output. The left channel output should be a 1000 cps sine-wave. See Figure 2-6, above.

7). Repeat the above test with the AUDIO control of the generator on the (right) R CHANNEL position.

8). Again observing the indicating instrument, adjust the separation control of the unit under test for minimum right channel information at the L channel output. Again ideally, no signal will be displayed, indicating perfect separation. In the event of insufficient separation, some right channel information (1000 cps audio signal) will be present in the L channel output.

NOTE

The output obtained at either the L or R channel of the unit under test may consist of not only a 1000 cps audio signal but also some 19KC and 38KC signals and harmonics of these frequencies. However, in well designed stereo receiving equipment these signals will be very small in amplitude and if not excessive will not interfer with listening pleasure as they are above the audible range. In tape recording they may be detrimental.

2-6. SEPARATION RATIO

The ideal signal separation ratio is 30db (decibel) or the approximate voltage ratio of 30:1. This

DECIBELS	0	1	2	3	4	5	6	7	8	9
VOLTAGE RATIO	1.00:1	1.12:1	1.26:1	1.41:1	1.58:1	1.78:1	2.00:1	2.24:1	2.51:1	2.82:1

DECIBELS	10	11	12	13	14	15	16	17	18	19
VOLTAGE RATIO	3.16:1	3.55:1	3.98:1	4.47:1	5.01:1	5.62:1	6.31:1	7.08:1	7.94:1	8.91:1

DECIBELS	20	21	22	23	24	25	26	27	28	29
VOLTAGE RATIO	10.0:1	11.2:1	12.6:1	14.1:1	15.8:1	17.8:1	20.0:1	22.4:1	25.1:1	28.2:1

DECIBELS	30	31	32	33	34	35	36	37	38	39
VOLTAGE RATIO	31.6:1	35.5:1	39.8:1	44.7:1	50.1:1	56.2:1	63.1:1	70.8:1	79.4:1	89.1:1

DECIBELS	40	60	80	100	
VOLTAGE RATIO	100:1	1000:1	10,000:1	100,000:1	

Figure 2-7. Relation Between Decibels and Voltage Ratios

ratio however, may not be obtained with every stereo adapter or stereo tuner. Channel separation is defined as the ratio of the signal amplitude obtained in the opposite channel when only the first channel is transmitting.

To determine the signal separation ratio of a particular stereo adapter or stereo tuner, balance the left and the right channels as explained in paragraph 2-4, and proceed as follows:

1). With the setup remaining as during the balancing, set the controls of the Model 727 as indicated, for L Channel Complete Composite Signal in chart, Figure 2-5.

2). Measure the output of the L channel and then the output of the R channel.

3). By comparing the ratio of the two outputs with the table, Figure 2-7, the separation ratio of the two channels may be read directly in decibels.

NOTE

For most critical listeners a separation of 20 db is satisfactory. This is a voltage separation ratio of 10 to 1. Any ratio below this ceases to be adequate stereo. The Model 727 produces a signal with a separation ratio of 30 db. This is a voltage ratio of 31.6 to 1

2-7. CHECK AND ALIGNMENT OF 38KC SUB-CARRIER

Insufficient separation or distortion may be the result of incorrect phase of the re-inserted sub-carrier relative to the received side-bands. Incorrect phase will result in reduced output from the L-R detector of a matrix type receiver with consequent loss of separation and distortion or both. In beam-switching type adapters the effect is basically the same, i. e., time that should be entirely devoted to the left channel is partially devoted to the right, and vice versa. The overall effect is loss of separation.

To test and align the 38KC sub-carr er phase of the stereo adapter or stereo tuner the L-R Detection Method is employed. To make this test select and connect the proper output of the Model 727 see Section 2-3a and 2-3b); the adapter or tuner to be tested; the available indicating equipment; and proceed as follows:

a). Rotate the ATTENUATOR to the most counter-clockwise (minimum) position. 1/

b). Turn the power switch of all equipment involved to the "ON" position. All units having tubes should be given at least 30 minutes warm-up time to stabilize. Model 727 being entirely transistorized requires no warm-up time.

c). Set the controls of the Model 727 as indicated, for Sidebands of L with 19KC Pilot in chart, Figure 2-5.

d). Adjust the 38KC sub-carrier phase on the unit under test by referring to the instructions supplied by the manufacturer of that particular unit. Adjustment should be made to produce the maximum recovered audio signal at both the R and L channel outputs. Check the outputs alternately if only one AC-VTVM or oscilloscope is used

e). As an additional check, change the AUDIO control of the generator to the (right) R CHANNEL position. The same results should be obtained.

NOTE

To get optimum separation after the 38KC sub-carrier phase has been adjusted, re-adjust the separation control as outlined in Section 2-5.

2-8. 19KC AND 38KC FILTER AND OSCILLATOR ALIGNMENT

Because of the many FM stereo adapters and stereo tuners on the market, and the differences in the circuits used, no precise instructions for alignment of the 19KC and 38KC filters or oscillators are practicable. Therefore the following instructions are of a general nature and must be used in connection with the manufacturer's instructions for the particular unit under test.

However, all stereo equipment must employ some means to regenerate the sub-carrier. In some circuits the sub-carrier is directly derived from the 19KC pilot signal by filtering the 19KC signal and then doubling it to obtain the 38KC sub-carrier signal for re-insertion. Other circuits use 19KC or 38KC oscillators which are synchronized by the 19KC pilot frequency. Therefore to align this part of a stereo circuit, strict adherence to the procedure outlined by the equipment manufacturer is strongly recommended.

The Model 727 provides a 19KC CW output accurate to within ±2 CPS for alignment of the 19KC filter (resonating) circuits and locked oscillators. The 19KC output amplitude of the Model 727 is at least 0.5 volt, peak-to-peak, with the AUDIO COMPOSITE ATTENUATOR turned fully clockwise. If an adapter is to be aligned care should be taken to adjust the output to the proper amplitude. The 19KC signal amplitude should be 10% of the input sensitivity of the stereo unit as specified by its manufacturer. If an FM stereo tuner is to be tested, no adjustment of the 19KC level is necessary as the above condition has been met in the RF OUTPUT 100MC.

The Model 727 also provides CW signal outputs of 38KC and 67KC for alignment of the various filters. In general, the 67KC rejection filter or trap is adjusted for maximum rejection of the 67KC signal. In aligning the 67KC trap, set the FUNCTION selector of the Model 727, to 67KC. Connect an oscilloscope or VTVM to the output of the 67KC trap of the unit under test and adjust for minimum signal output.

1/ Disregard this step if RF OUTPUT is used.

Bandpass filters with a range of 23 to 53KC combine the function of eliminating the SCA sub-carrier, and of passing the L-R sidebands. Alignment procedures generally include peaking the filter at 38KC with a maximum rejection at 67KC.

A 38KC sine wave output is obtained from the Model 727 by setting the controls for 38KC Sine Wave as indicated in chart, Figure 2-5.

2-9. CHECK OF TUNER RESPONSE

Before a properly aligned adapter is connected to the tuner with which it is to operate, it is desirable to check the response of the tuner. If the tuner is not ideal in terms of flatness of response and lack of phase shift, the stereo composite signal will not be faithfully reproduced. It is also desirable to know the recovered signal amplitude at the multiplex output jack of the tuner under conditions of peak deviation of 75KC (100% FM modulation). Ideally, the output voltage obtained should match the stated input sensitivity of the adapter. To check both the response and the obtained output signal, proceed as follows:

a). Set the controls of the Model 727 for L Channel Composite Signal without 19KC Pilot as indicated in chart, Figure 2-5.

b). Connect the RF OUTPUT 100MC to the antenna terminals of the tuner under test.

c). Connect a low capacity shielded cable from the multiplex output jack of the tuner to the vertical input of an oscilloscope.

d). Set the vertical sensitivity control of the oscilloscope to indicate a signal of approximately 4 volts, peak-to-peak.

Figure 2-8. Properly Balanced Right OR Left Channel

e). Very carefully adjust the tuning dial of the FM tuner to the point on the dial (about 100MC) where a pattern as shown in Figure 2-8, is obtained on the oscilloscope. While observing the tuning indicator or the oscilloscope, adjust the tuning dial slightly to the right and to the left, to be absolutely certain that the dial is turned to the correct frequency. In the properly tuned state the ideal signal will have the appearance as shown in Figure 2-8.

> NOTE
>
> If the pattern shows a concave bowing in the baseline, the higher frequencies (L-R sidebands) are attenuated. A small amount is normal in most tuners. If the baseline shows excessive tilt, the low frequency response is poor. If the pattern has a baseline distortion other than uniform bowing, the tuner has poor phase response. If the effects mentioned above are considerable, a re-alignment of the tuner is recommended.

f). Set the 19KC PILOT switch to the 10% position.

g). Measure the signal amplitude as displayed on the oscilloscope. The measured amplitude is the output received under conditions of peak deviation. For good stereo performance the signal amplitude should not deviate greatly from the specified input sensitivity of adapter with which it will be used.

2-10. MATCHING TUNER AND ADAPTER

After the adapter has been aligned and the tuner has been checked, connect the Model 727; the tuner; the adapter; and the indicating instruments as shown in Figures 2-2, 2-3, or 2-4; and proceed as follows:

a). Set the controls of the Model 727 for L Channel Complete Composite Signal as indicated on chart, Figure 2-5.

b). While observing the tuning indicator, very carefully adjust the tuning to the RF frequency transmitted by the Model 727 (100MC). This tuning must be very accurate.

c). Check the separation. If the separation is not satisfactory, adjust for optimum condition as explained in Section 2-5. This will compensate for any high or low frequency losses which occurred in the tuner circuit. Refer to the NOTE in Section 2-9.

SECTION 3

MAINTENANCE

3-1. GENERAL

The Model 727 FM-Stereo Multiplex Generator is a precise test instrument, it is completely transistorized, and very rugged. Maintenance is confined to an occasional and slight "touch-up" of the "GAIN" control (Figure 3-1) which may be reached through an access hole on the outside bottom of the instrument. This infrequent adjustment may be necessitated by gradual diminishing of the battery voltage.

To insure that the test signals produced by the Model 727 agree with the specifications at all times, a periodic re-calibration and fidelity check may be desirable. The re-calibration and fidelity check controls may be reached from the outside of the case through access holes in the back, left side, and bottom without removing the instrument from its case.

Before making these tests, remove (but do not disconnect) the battery and check the terminal voltage under full load conditions. This is accomplished with POWER switch in the "ON" position and the FUNCTION selector in the "STEREO" position. If the battery voltage is 18 volts or less, replace the battery. For type and size of battery, see Section 2-1.

3-2. AUDIO COMPOSITE OUTPUT AMPLITUDE CHECK

To check the fidelity of and/or re-calibrate the Model 727, proceed as follows:

a). Connect the AUDIO COMPOSITE OUTPUT of the Model 727 to the vertical input of an oscilloscope.

> **NOTE**
>
> The oscilloscope must have a vertical passband frequency of not less than 4.5 MC, and have capabilities for vertical deflection measurements.

b). Set the front panel controls of the Model 727 as follows:

AUDIO selector	L CHANNEL
L + R	ON
FUNCTION selector	STEREO
19KC PILOT switch	OFF
POWER ON-OFF	ON

Allow approximately 10 minutes warm-up time for all components to stabilize.

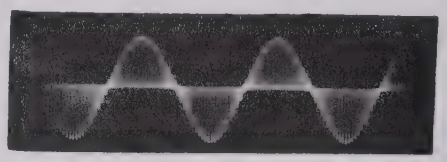


Figure 3-2. Properly Balanced Right OR Left Channel Signal

c). At this point a signal should be displayed on the oscilloscope similar to **Figure 3-2**, with a peak-to-peak amplitude of **3.6 volts. If** the signal obtained varies more than 5% from 3.6 volts (3.42 - 3.78 volts), adjust the GAIN control (Figure 3-1) until this condition **has been met.**

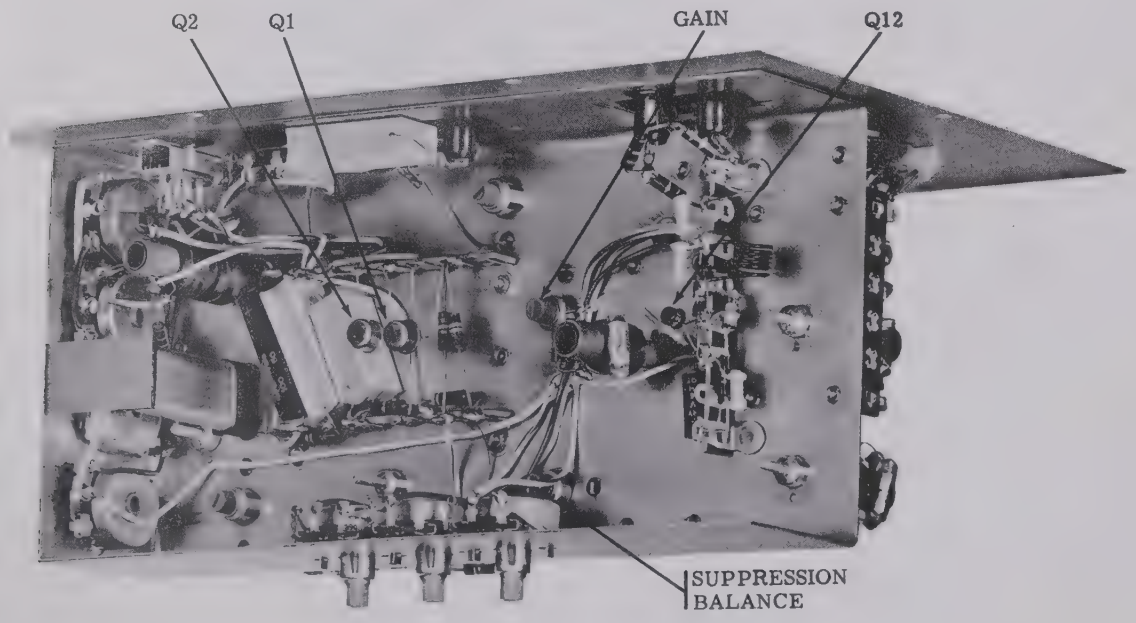


Figure 3-1. Bottom View of Chassis Showing Calibration Controls

Figure 3-3. Improperly Balanced Right OR Left Channel Signal

d). Change the AUDIO selector to the R CHANNEL. A signal, the exact duplicate as to form and amplitude as observed for the L Channel, should now be displayed on the oscilloscope. If the signal displayed in either the L or R position shows any concave or convex bowing of the baseline (concave is shown in Figure 3-3), improper L+ R or L-R level is indicated and should be corrected by the procedure outlined in Section 3-3, below.

3-3. LEFT PLUS RIGHT VERSUS LEFT MINUS RIGHT BALANCE CHECK

To check or re-balance left plus right (L+ R) channel against left minus right (L-R) channel, proceed as follows. This step should be preceded by an audio composite output amplitude check. See Section 3-2.

a). Set the front panel controls of the Model 727 as follows:

AUDIO selector	L CHANNEL
L+ R switch	OFF
FUNCTION selector	STEREO
19KC PILOT switch	OFF
POWER ON-OFF	ON

Allow approximately 10 minutes warm-up time for all components to stabilize.

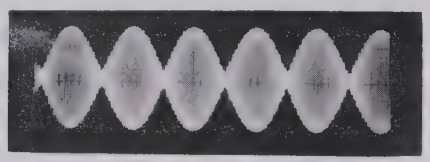


Figure 3-5. Sidebands of Right OR Left Channels Only

b). At this point a signal should be displayed on the oscilloscope showing an apparently interwoven sine wave as shown in Figure 3-5, with an amplitude of 1.8 volts peak-to-peak. If this requirement is not met, adjust the L control of the L-R LEVEL (Figure 3-4) until the condition has been met.

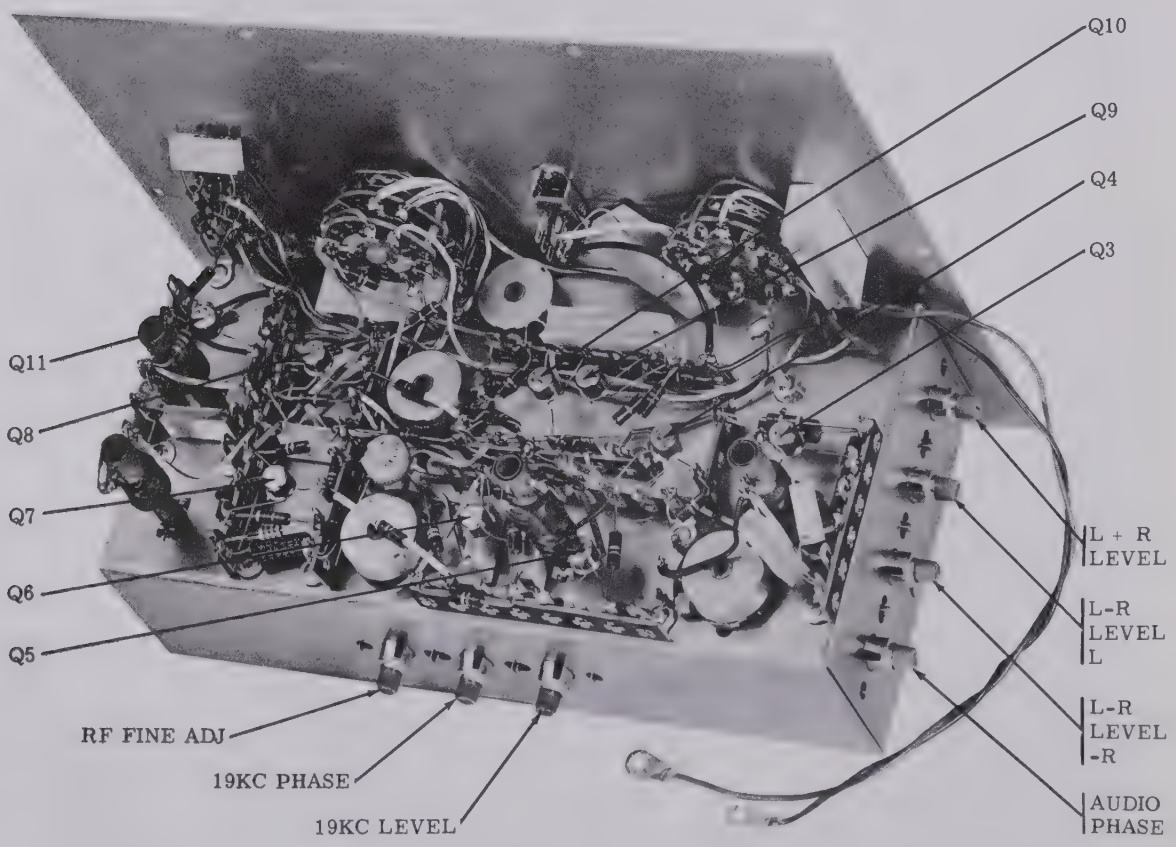


Figure 3-4. Top View of Chassis Showing Calibration Controls

If the displayed signal shows the adjacent sine waves with alternately different amplitudes, it is indicative of poor 38KC suppression. Adjust the SUPPRESSION BALANCE control (Figure 3-1) to achieve a signal display as shown in Figure 3-5. Access to the SUPPRESSION BALANCE control is gained through the access hole on the bottom of Model 727.

c). With the controls set as shown above, change the AUDIO selector to the R CHANNEL position. The displayed signal shall be again as shown in Figure 3-5. If the displayed signal needs adjustment, it may be accomplished by means of the -R (minus R)control (Figure 3-4) of the L-R LEVEL adjustment. The displayed signal must meet the specified amplitude. Access to this adjustment is gained through the access hole on the left side of the Model 727.

d). With the controls set as above, change the L-R switch to the ON position. The displayed signal shall be as shown in Figure 3-2. If the baseline has a concave or a convex bowing, adjust the L+ R LEVEL control to produce a pattern on the oscilloscope as shown in Figure 3-2. Access to this adjustment is gained through the access hole on the left side of the Model 727.

e). With the controls set as above, change the AUDIO selector to the L CHANNEL position. The displayed signal shall again be as shown in Figure 3-2. If the baseline is bowed, correction is accomplished by adjustment of the L control (Figure 3-4) of the L- R LEVEL adjustment. Access to this adjustment is gained through the access hole on the left side of the Model 727.

3-4. 19KC PILOT PHASE AND AMPLITUDE CHECK

To check and/or adjust the 19KC pilot signal of the Model 727 for phase and amplitude, proceed as follows:

a). Set the front panel controls of the Model 727 as follows:

AUDIO selector	L CHANNEL
L+ R switch	OFF
FUNCTION selector	STEREO
19KC PILOT switch	OFF
POWER ON-OFF	ON

Allow approximately 10 minutes warm-up time for all components to stabilize.

b). A signal as shown in Figure 3-5 should now be displayed on the oscilloscope. If the displayed signal shows the adjacent sine waves with alternately different amplitudes, adjust the SUPPRESSION BALANCE control (Figure 3-1) to achieve a signal display as shown in Figure 3-5. Access to the SUPPRESSION BALANCE control is gained through the access hole on the bottom of the Model 727.

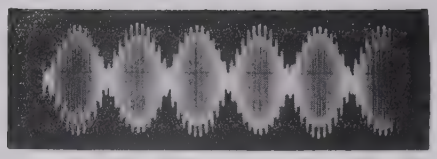


Figure 3-6. Incorrect 19KC Phase Adjustment

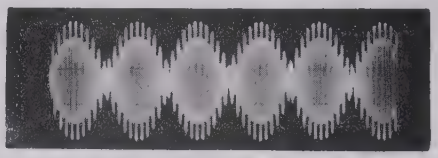


Figure 3-7. Correct 19KC Phase Adjustment

c). With the controls set as shown above, change the 19KC PILOT switch on the front panel to the 10% position. If the 19KC serrations are not equally distributed on the top and bottom of the signal pattern as illustrated in Figure 3-7, but are as shown in Figure 3-6, adjust the 19KC PHASE control to produce a signal as shown in Figure 3-7. Access to the 19KC PHASE control is gained through the access hole on the rear of Model 727.

d). The proper amplitude of the 19KC pilot signal, if phased correctly will produce 19KC serrations on the top and on the bottom of the displayed pattern. The amplitude of these serrations shall be 0. 28 volts. If the amplitude of the 19KC serrations is not as specified adjust the 19KC LEVEL control (Figure 3-4) to meet this requirement. Access to the 19KC LEVEL control is gained through the access hole on the rear of the Model 727.

e). With the controls set as above, change the 19 KC PILOT switch on the front panel to the 5% position. The 19KC serration amplitude on the top and on the bottom of the pattern on the oscilloscope shall be reduced to 0. 14 volts, ±15% (0. 12-0. 16 volts).

3-5. AUDIO PHASE CHECK

Precede this step by conducting a check of the audio composite output amplitude as outlined in Section 3-2. If the baseline of Figure 3-2 shows a tilt in each half cycle portion of the signal displayed in excess of 2. 5% of the entire composite signal, adjust the AUDI O PHASE control in conjunction with the L+ R LEVEL control (Figure 3-4) to correct the audio phase shift. Access to the AUDIO PHASE control and the L+ R LEVEL control is gained through the access hole on the left side of Model 727.

> NOTE
> The tilt as observed on the oscilloscope may be caused by poor low frequency response of the oscilloscope. Check the low frequency response of the oscilloscope by feeding a 1000 cps square wave into the vertical input of the oscilloscope. There should be no tilting of the square wave.

NOTES

SECTION 4

CIRCUIT DESCRIPTION

4-1. GENERAL

The circuitry of the Model 727 Multiplex Generator is completely transistorized. All power requirements are provided by a single 22.5 volt battery, such as Eveready No. 763, or equivalent.

The block diagram (figure 4-1) illustrates the circuitry in block form; the schematic wiring diagram (figure 4-2) in the rear of this manual should be used for individual component identification.

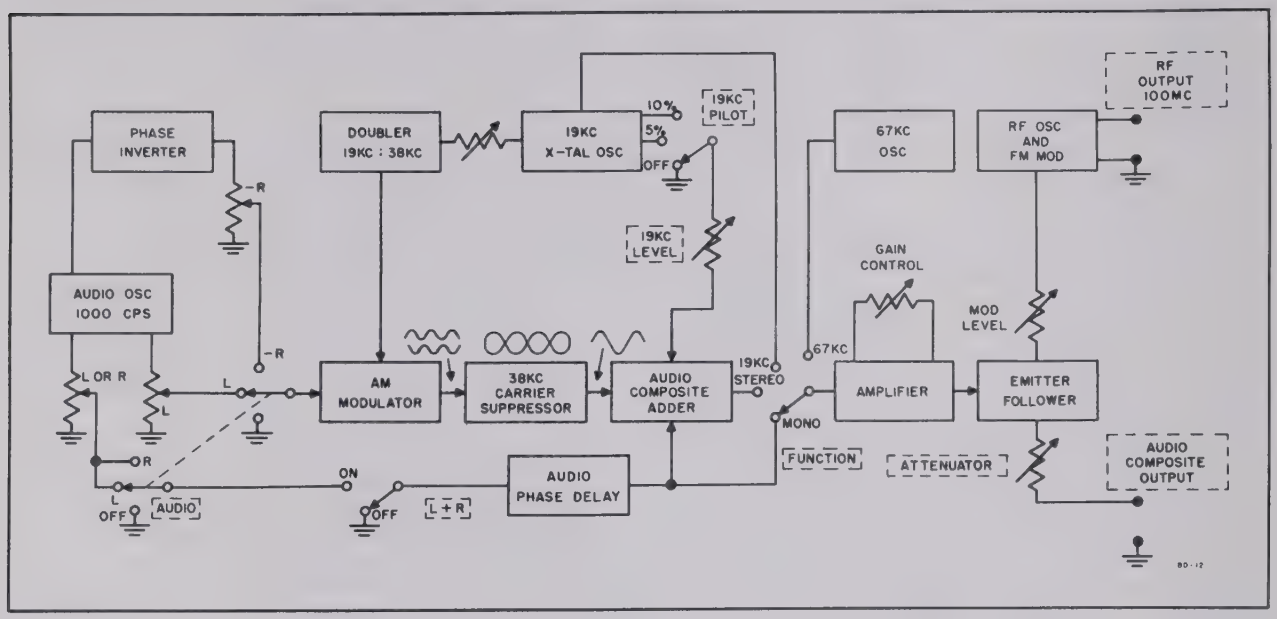


Figure 4-1. Block Diagram, FM Stereo Multiplex Generator, Model 727

To simplify the circuit description of the Model 727 FM-STEREO MULTIPLEX GENERATOR, the circuit description is divided into eleven (11) functional units as follows:

1. 1KC Audio Oscillator
2. Phase Inverter
3. 19KC Oscillator
4. 19KC:38KC Doubler
5. AM Modulator
6. 38KC Carrier Suppressor
7. Audio Composite Adder
8. Audio Phase Delay
9. 67KC Oscillator
10. Final Amplifier and Emitter Follower
11. RF Oscillator and FM Modulator

4-2. 1KC AUDIO OSCILLATOR

The internally generated 1KC L (left) and R (right) signals are developed by a conventional colpitts type oscillator, using a tuned 1KC tank circuit. The L and R output signals which are fed to the base-emitter junction of Q2 are the same in frequency of oscillation and in amplitude. Q1 and the associated components form the 1KC audio oscillator.

4-3. PHASE INVERTER

To produce the L-R and the L+R signal the output of the 1KC oscillator Q1 is applied to the base-emitter junction of Q2, the phase inverter stage. The signal developed in the collector circuit of Q2 is phase shifted 180 degrees from the input signal. Both the emitter and collector signals are fed to the AUDIO switch. The collector signal of the inverter stage constitutes the -R signal, and the emitter signal of the Inverter stage the +R signal.

The Variable resistor L-R LEVEL, -R (R7) (located on the left side of the chassis) is a screwdriver adjustment, which permits control of the amplitude of the -R signal. See schematic wiring diagram and figure 3-4, Top View of Chassis Showing Calibration Controls. The signal at the emitter of Q1 is controlled by L+R LEVEL (R8), and L-R LEVEL, L (R9) (located on the left side of the chassis). The L+R LEVEL (R8) controls the amplitude of the L+R signal and L-R LEVEL, L (R9) controls the amplitude of the L-R signal. Both are screwdriver adjustments.

4-4. 19KC OSCILLATOR

Because of the critical frequency and phase stability requirements of the 19KC pilot signal,a crystal controlled oscillator is used to generate the 19KC signal. Q3, CR1, and their associated circuitry form the 19KC generator. The signal is accurate to within ±2 cps of its nominal 19KC frequency. The 19KC PILOT signal developed across the collector load resistor R12, is phase shifted 180 degrees from the input signal by the network consisting of CR1, C4, C5, and L12. The 19KC oscillator signal is coupled from the 19KC oscillator (Q3) to the 19KC amplifier (Q4) by R26, the 19KC LEVEL adjust.

4-5. 19KC:38KC DOUBLER

The collector circuit of Q4 is tuned to 19KC. The 38KC signal is derived from the 19KC signal by the doubler circuit. The 38KC signal is obtained by inverting the negative half cycle of the 19KC sinusoidal signal, and adding it to the positive half cycle of the 19KC signal. This produces 38KC pulses, which are applied to the 38KC filter amplifier Q6, and formed into a sinusoidal 38KC signal at the collector of Q6.

From the collector of Q4, the 19KC signal is applied to the base of Q5, an emitter follower. The 19KC emitter signal is applied to the 19KC LEVEL adjust (R61) which permits the adjustment of the amplitude of this signal. C27 couples the signal to switch 19 KC PILOT (S5) where the 19KC signal is reduced to the desired, 5%, or 10% of the total composite output signal and applied to the audio composite adder.

4-6. AM MODULATOR

The L-R signal from the AUDIO switch (S1) is applied to the emitter of Q7. The 38KC subcarrier from the filter amplifier (Q6) is applied to the base of Q7. The collector output of Q7 is the modulated 38KC waveform containing the side bands of L-R.

4-7. 38KC CARRIER SUPPRESSOR

Since only the sidebands carry useful information, the 38KC carrier itself is suppressed by the addition of an out-of-phase 38KC signal to the modulation product. Suppression takes place at the common load resistor, R45. The block diagram (figure 4-1) illustrates the 38KC subcarrier before and after the carrier is suppressed.

4-8. AUDIO COMPOSITE ADDER

The L-R sidebands, the L+R signal, and the 19KC pilot signal are combined, or added, in the audio composite adder stage. The composite adder stage is a resistive network consisting of R49, R51, and R52. The output of the composite adder is coupled through R53 to the base of the final amplifier (Q9). The L-R sideband signal from the collector of Q8 is coupled through R49 to the signal end of R51. The L+ R signal from the audio phase delay is coupled through R52, to the signal end of R51. The 19KC pilot signal, and the product of the L+R and the L-R components are jointly coupled to the base of the final amplifier, Q9, to form the stereo composite signal.

4-9. AUDIO PHASE DELAY

The Audio Phase Delay consists of AUDIO PHASE control (R25), (located on the left side of the chassis, see figure 3-4) and C10. The purpose of the audio phase delay is to assure proper phase relation between the L+ R signal and the L-R signal components.

4-10. 67KC OSCILLATOR

A 67KC signal is generated for adjustment of the Subsidiary Communications Authorization (SCA) trap. The colpitts oscillator, Q11 and its associated circuitry constitute the 67KC oscillator.

4-11. FINAL AMPLIFIER AND EMITTER FOLLOWER

The stereo composite signal is coupled from the audio composite adder by C26 to the base of Q9, the final amplifier stage. The output signal of Q9 is amplified and applied to the base of Q10, the emitter follower. The emitter output of Q10 is attenuated by the AUDIO COMPOSITE ATTENUATOR (R59) and is coupled by C30 to the AUDIO COMPOSITE OUTPUT terminal located on the front panel. The collector output of Q10 is coupled by the modulator level control (R58) which permits adjustment of the composite signal being applied to the RF oscillator and FM modulator.

4-12. RF OSCILLATOR AND FM MODULATOR

To produce frequency modulation a common base RF oscillator is used. The tank circuit of this oscillator consists of C14, L6, and R76.

When the audio composite signal is applied to the collector of Q12, the reactance of the tank circuit varies in rhythm with the applied composite signal. As a result, the RF oscillator frequency will deviate from its center frequency in accordance with the reactance changes in the tank circuit. Thus frequency modulation is accomplished. The FM carrier is coupled by L7 to a resistive divider, consisting of R18, R19, and R20, and applied to the RF OUTPUT terminal on the front panel. The RF carrier frequency is 100 mc and can be adjusted ±250KC by the RF FINE ADJ. control at the rear panel of the unit.

SECTION 5

PARTS LIST

5-1. INTRODUCTION.

Reference designations are assigned to identify all parts of the Model 727, FM Stereo Multiplex Generator. These designations are used in the Parts List and Schematic Wiring Diagram. The letter prefix of a reference designation indicates the kind of part -- resistor, capacitor, transistor, etc. The number differentiates between parts in the same group.

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
A1		CABLE ASSEMBLY: Output	3030-175	6.00
BT1		BATTERY: Dry cell 22.5 volts		
C1		CAPACITOR, FIXED, MYLAR: .47 uf, 20%, 200 Volts	3090-33	.40
C2		CAPACITOR, FIXED, MYLAR: .33 uf, 20%, 200 Volts	3090-32	.40
C3		CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, 6 Volts	3085-154	.75
C4		CAPACITOR, FIXED, MYLAR: .0068 uf, 20%, 200 Volts	3090-31	.15
C5		CAPACITOR, FIXED, MYLAR: .068 uf, 20%, 200 Volts	3090-34	.20
C6		CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, 50 Volts	3085-127	1.00
C7		Same as C1		
C8		Same as C1		
C9		Not Assigned		
C10		CAPACITOR, FIXED, FILM: 2200 uuf, 5%, 125 Volts	3100-222	.20
C11		CAPACITOR, FIXED, CERAMIC: 2 uuf, zero temp. coeff, 10%	3110-35	.30
C12		Same as C3		
C13		CAPACITOR, FIXED, CERAMIC: 1000 uuf, 10%, 500 Volts	3110-112	.30
C14		CAPACITOR, FIXED, CERAMIC: 4.7 uuf, zero temp. coeff, 10%	3110-207	.30
C15		Same as C13		
C16		CAPACITOR, FIXED, FILM: 560 uuf, 5%, 125 Volts	3100-561	.20
C17		Same as C1		
C18		Same as C10		
C19		CAPACITOR, FIXED, MYLAR: .047 uf, 20%, 200 Volts	3090-27	.20
C20		Same as C10		
C21		Same as C19		
C22		CAPACITOR, VARIABLE: 3-12 uuf, NPO	3115-40	.80
C23		Same as C10		

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
C24		Same as C3		
C25		Same as C19		
C26		Same as C1		
C27		Same as C19		
C28		Not Assigned		
C29		CAPACITOR, FIXED, FILM: 270 uuf, 5%, 125 Volts	3100-271	.20
C30		Same as C1		
C31		CAPACITOR, FIXED, FILM: 4700 uuf, 5%, 125 Volts	3100-472	.20
C32		CAPACITOR, FIXED, FILM: 1000 uuf, 5%, 125 Volts	3100-102	.20
C33		Same as C19		
CR1		CRYSTAL: 19 kc	3870-88	27.95
CR2		SEMI-CONDUCTOR DEVICE, ZENER DIODE: 14V, 3/4 W, 10%	3870-113	3.05
CR3		SEMI-CONDUCTOR DEVICE, DIODE: 1N34AS	3870-78	.50
CR4		Same as CR3		
J1		JACK: pin, 3/32", red	10300-8	.10
J2		JACK: pin, 3/32", black	10300-11	.10
J3		Same as J1		
J4		Same as J2		
J5		PLUG: pin type, red	16525-29	.15
J6		PLUG: pin type, black	16525-40	.15
L1		COIL ASSEMBLY: 100 mh, audio osc.	3320-303	3.00
L2		COIL ASSEMBLY:	3320-305	12.00
L3		COIL ASSEMBLY: 19:38 kc doubler transformer	3320-304	14.72
L4		Same as L2		
L5		Same as L2		
L6		COIL, RF: 7 turns	3320-308	2.50
L7		COIL, RF: 2 turns	3320-307	2.50
L8		Same as L2		
MP1		KNOB ASSY: bar type, with pointer	11500-11	.45
MP2		Same as MP1		
MP3		KNOB: round, skirted, 1-1/8" dia, indicator lines filled with white.	11505-121	.75

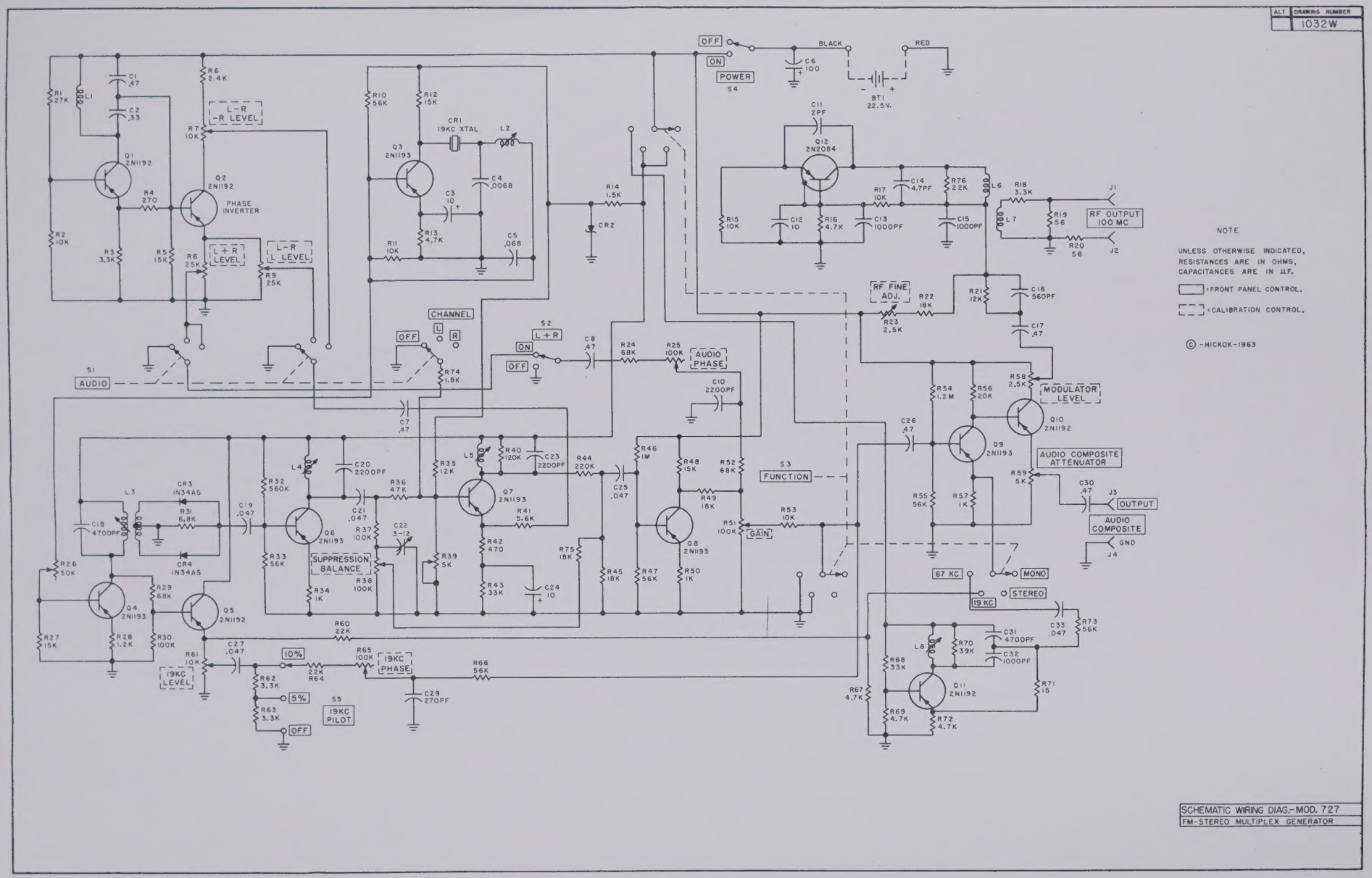
Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
Q1		TRANSISTOR: 2N1192	20861-40	1.50
Q2		Same as Q1		
Q3		TRANSISTOR: 2N1193	20861-21	2.00
Q4		Same as Q3		
Q5		Same as Q1		
Q6		Same as Q3		
Q7		Same as Q3		
Q8		Same as Q3		
Q9		Same as Q3		
Q10		Same as Q1		
Q11		Same as Q1		
Q12		TRANSISTOR: 2N2084	20861-31	2.15
R1		RESISTOR, FIXED, COMPOSITION: 27K ohms, 5%, 1/2 W	18413-271	.25
R2		RESISTOR, FIXED, COMPOSITION: 10K ohms, 5%, 1/2 W	18413-101	.25
R3		RESISTOR, FIXED, COMPOSITION: 3300 ohms, 10%, 1/2 W	18412-332	.15
R4		RESISTOR, FIXED, COMPOSITION: 270 ohms, 10%, 1/2 W	18411-272	.15
R5		RESISTOR, FIXED, COMPOSITION: 15K ohms, 10%, 1/2 W	18413-152	.15
R6		RESISTOR, FIXED, COMPOSITION: 2400 ohms, 5%, 1/2 W	18412-241	.25
R7		RESISTOR, VARIABLE, COMPOSITION: 10K ohms, 20%, 1/2 Watt	40500-103	1.00
R8		RESISTOR, VARIABLE, COMPOSITION: 25K ohms, 20%, 1/2 Watt	40500-253	1.00
R9		Same as R8		
R10		RESISTOR, FIXED, COMPOSITION: 56K ohms, 10%, 1/2 W	18413-562	.15
R11		RESISTOR, FIXED, COMPOSITION: 10K ohms, 10%, 1/2 W	18413-102	.15
R12		Same as R5		
R13		RESISTOR, FIXED, COMPOSITION: 4700 ohms, 10%, 1/2 W	18412-472	.15
R14		RESISTOR, FIXED, COMPOSITION: 1500 ohms, 10%, 1/2 W	18412-152	.15
R15		Same as R11		
R16		Same as R13		
R17		Same as R11		
R18		Same as R3		
R19		RESISTOR, FIXED, COMPOSITION: 56 ohms, 10%, 1/2 W	18410-562	.15

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R20		Same as R19		
R21		RESISTOR, FIXED, COMPOSITION: 12K ohms, 5%, 1/2 W	18413-121	.25
R22		RESISTOR, FIXED, COMPOSITION: 18K ohms, 5%, 1/2 W	18413-181	.25
R23		RESISTOR, VARIABLE, COMPOSITION: 2500 ohms, 20%, 1/2 Watt	40500-252	1.00
R24		RESISTOR, FIXED, COMPOSITION: 68K ohms, 10%, 1/2 Watt	18413-682	.15
R25		RESISTOR, VARIABLE, COMPOSITION: 100K ohms, 20%, 1/2 Watt	40500-104	1.00
R26		RESISTOR, VARIABLE, COMPOSITION: 50K ohms, 20%, 1/2 Watt	40500-503	1.00
R27		Same as R5		
R28		RESISTOR, FIXED, COMPOSITION: 1200 ohms, 5%, 1/2 Watt	18412-121	.25
R29		Same as R24		
R30		RESISTOR, FIXED, COMPOSITION: 100K ohms, 10%, 1/2 Watt	18414-102	.15
R31		RESISTOR, FIXED, COMPOSITION: 6800 ohms, 10%, 1/2 Watt	18412-682	.15
R32		RESISTOR, FIXED, COMPOSITION: 560K ohms, 10%, 1/2 Watt	18414-562	.15
R33		Same as R10		
R34		RESISTOR, FIXED, COMPOSITION: 1000 ohms, 5%, 1/2 Watt	18412-101	.25
R35		Same as R21		
R36		RESISTOR, FIXED, COMPOSITION: 47K ohms, 10%, 1/2 Watt	18413-472	.15
R37		Same as R30		
R38		Same as R25		
R39		RESISTOR, VARIABLE: 5K ohms, 30%, 1/4 Watt	16925-505	1.00
R40		RESISTOR, FIXED, COMPOSITION: 120K ohms, 10%, 1/2 Watt	18414-122	.15
R41		RESISTOR, FIXED, COMPOSITION: 5600 ohms, 10%, 1/2 Watt	18412-562	.15
R42		RESISTOR, FIXED, COMPOSITION: 470 ohms, 5%, 1/2 W	18411-471	.25
R43		RESISTOR, FIXED, COMPOSITION: 33K ohms, 10%, 1/2 W	18413-332	.15
R44		RESISTOR, FIXED, COMPOSITION: 220K ohms, 10%, 1/2 Watt	18414-222	.15

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R45		Same as R22		
R46		RESISTOR, FIXED, COMPOSITION: 1 megohm, 10%, 1/2 Watt	18415-102	.15
R47		Same as R10		
R48		RESISTOR, FIXED, COMPOSITION: 15K ohms, 5%, 1/2 Watt	18413-151	.25
R49		Same as R22		
R50		Same as R34		
R51		Same as R25		
R52		Same as R24		
R53		Same as R11		
R54		RESISTOR, FIXED, COMPOSITION: 1.2 megohms, 10%, 1/2 Watt	18415-122	.15
R55		RESISTOR, FIXED, COMPOSITION: 56K ohms, 5%, 1/2 Watt	18413-561	.25
R56		RESISTOR, FIXED, COMPOSITION: 20K ohms, 5%, 1/2 Watt	18413-201	.25
R57		Same as R34		
R58		Same as R23		
R59		RESISTOR, VARIABLE, COMPOSITION: 5K ohms, 10%, 1/2 Watt	40300-502	1.00
R60		RESISTOR, FIXED, COMPOSITION: 22K ohms, 10%, 1/2 Watt	18413-222	1.00
R61		Same as R7		
R62		Same as R3		
R63		Same as R3		
R64		Same as R60		
R65		Same as R25		
R66		Same as R10		
R67		Same as R13		
R68		Same as R43		
R69		Same as R13		
R70		RESISTOR, FIXED, COMPOSITION: 39K ohms, 10%, 1/2 Watt	18413-392	.15
R71		RESISTOR, FIXED, COMPOSITION: 15 ohms, 10%, 1/2 Watt	18410-152	.15
R72		Same as R13		

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R73		Same as R10		
R74		RESISTOR, FIXED, COMPOSITION: 1800 ohms, 10%, 1/2 Watt	18412-182	.15
R75		Same as R22		
R76		Same as R60		
S1		SWITCH, ROTARY: Audio Channel Selector, 1 section, 3 position	19912-540	3.00
S2		SWITCH, SLIDE: DPDT	19911-83	1.50
S3		SWITCH, ROTARY: Function Selector, 2 section, 4 position	19912-541	4.95
S4		Same as S2		
S5		SWITCH, SLIDE: DPTT	19911-74	1.50
		BOOKLET, INSTRUCTION:	2490-491	1.50

Note: A minimum billing charge of $3.50 will be assessed for any parts order.
Prices are subject to Change without notice.


ALT
DRAWING NUMBER
1032W
OFF
ON
POWER
S4
BLACK
RED
C6 100
BT1 22.5V.
C11 2PF
Q12 2N2084
C14 4.7PF
R76 22K
L6
R18 3.3K
J1
R17 10K
R15 10K
C12 10
R16 4.7K
C13 1000PF
C15 1000PF
L7
R19 56
RF OUTPUT 100 MC
R20 56
J2
NOTE
UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN MF.
+FRONT PANEL CONTROL.
+CALIBRATION CONTROL.
© -HICKOK-1963
R1 27K
L1
C1 .47
C2 .33
R6 2.4K
L-R -R LEVEL
R7 10K
Q1 2N1192
Q2 2N1192
PHASE INVERTER
R4 270
R2 10K
R3 3.3K
R5 15K
R8 25K
L+R LEVEL
L-R L LEVEL
R9 25K
R10 56K
R12 15K
CR1 19KC XTAL
L2
Q3 2N1193
C4 .0068
C3 10
R13 4.7K
C5 .068
R11 10K
R14 1.5K
CR2
RF FINE ADJ.
R22 18K
R23 2.5K
R21 12K
C16 560PF
C17 .47
CHANNEL
L
R
OFF
S2
L+R
ON
OFF
C8 .47
R24 68K
R25 100K
AUDIO PHASE
S1
AUDIO
R74 1.8K
C10 2200PF
C7 .47
R54 1.2M
R56 20K
R58 2.5K
MODULATOR LEVEL
Q10 2N1192
Q9 2N1193
C26 .47
AUDIO COMPOSITE ATTENUATOR
R59 5K
R55 56K
R57 1K
C30 .47
J3
OUTPUT
AUDIO COMPOSITE
GND
J4
L3
CR3 1N34AS
C18 4700PF
R31 6.8K
CR4 1N34AS
L4
C20 2200PF
R32 560K
C19 .047
R36 47K
C21 .047
R37 100K
C22 3-12
R33 56K
SUPPRESSION BALANCE
R38 100K
R34 1K
R39 5K
L5
R35 12K
R40 120K
C23 2200PF
Q7 2N1193
R41 5.6K
R42 470
R43 33K
C24 10
R44 220K
C25 .047
R46 1M
R48 15K
R52 68K
S3
FUNCTION
R49 18K
R51 100K
GAIN
R53 10K
Q8 2N1193
R75 18K
R45 18K
R47 56K
R50 1K
R26 50K
R29 68K
Q4 2N1193
Q5 2N1192
R27 15K
R28 1.2K
R30 100K
67 KC
MONO
STEREO
19 KC
C33 .047
R73 56K
R60 22K
L8
C31 4700PF
R70 39K
C32 1000PF
R68 33K
R67 4.7K
Q11 2N1192
R71 15
R69 4.7K
R72 4.7K
R61 10K
19KC LEVEL
C27 .047
10%
R65 100K
19KC PHASE
R66 56K
R62 3.3K
22K R64
5%
R63 3.3K
OFF
S5
19KC PILOT
C29 270PF
SCHEMATIC WIRING DIAG.-MOD. 727
FM-STEREO MULTIPLEX GENERATOR